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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job uties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

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Development of USES Aptitude Test Battery for Instrument Repairman

(any ind.) I 710.281

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Technical Report on Development of USES Aptitude Test Battery

For .....

Instrument Repairman (any ind.) I 710.281

S-318R

U. S. Employment Service
in Cooperation with
Pennsylvania and Texas State Employment Services

Revised January 1967

FOREWORD

The United States Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 aptitudes: General Learning Ability, Verbal Aptitude, Numerical Aptitude, Spatial Aptitude, Form Perception, Clerical Perception, Motor Coordination, Finger Dexterity, and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

Frank H. Cassell

Frank H. Cassell, Director
U. S. Employment Service

GATB #2513, and 2634

DEVELOPMENT OF USES APTITUDE TEST BATTERY

For

Instrument Repairman (any ind.) I 710.281
S-318R

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Instrument Repairman I 710.281. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB, B-1002B Scores
N - Numerical Aptitude	85
S - Spatial Aptitude	100
P - Form Perception	80

RESEARCH SUMMARY

Sample:
65 male students enrolled as Instrument Repairman Trainees in an MDTA training course at Lee Junior College, Baytown Texas.

Criterion:
Course grades.

Design:
Longitudinal (tests administered before training and criterion data collected throughout training period).

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

Predictive Validity
Phi Coefficient = .35 (P/2 $<$.005)

Effectiveness of Norms
Only 72% of the non-test-selected trainees used for this study turned out to be good workers; if the trainees had been test-selected with the S-318 norms, 79% would have been good workers. 28% of the non-test-selected trainees used for this study were poor workers; if the trainees had been test-selected with the S-318 norms, only 21% would have

been poor workers. The effectiveness of the norms is shown graphically in Teble 1:

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Workers	72%	79%
Poor Workers	28%	21%

SAMPLE DESCRIPTION

Size: N = 65

Occupational Status: Trainees

Work Setting: Students enrolled in MDTA training course at Lee Junior College, Baytown, Texas.

Training Selection Requirements:

Education: High school graduation

Previous Experience: None

Other: Courses in physics recommended.

Principal Activities: The duties of the jobs for which the trainees were being trained are comparable to those shown in the job description in the Appendix.

Minimum Experience: None of the trainees had prior experience in the occupation.

TABLE 2

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age and Education

	Mean	SD	Range	r
Age (years)	26.4	4.3	21-35	.144
Education (years)	12.7	1.1	12-16	-.023

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B, were administered to the sample group in November 1963.

CRITERION

The criterion consisted of final course grades representing an average between final examination scores and interim grades. The same final examination was administered to all trainees.

An adaptation of the USES Form SP-21, "Descriptive Rating Scale," containing items with particular consideration for proficiency in Laboratory exercises and for potential success on the job was used as a second criterion.

Reliability:

A reliability coefficient of .82 resulted when the final course grades and SP-21 ratings were correlated. In view of this and because there were no significant differences between the two sets of correlations with individual aptitude scores on the GATB, the final criterion selected was final course grades only.

Criterion Score Distribution:

Actual Range:	70-98
Mean:	88.5
Standard Deviation:	7.9

Criterion Dichotomy:

The criterion distribution was dichotomized into low and high groups by placing 28% of the sample in the low group to correspond with the percentage of trainees considered unsatisfactory or marginal. Trainees in the high criterion group were designated as "good trainees" and those in the low group as "poor trainees." The criterion critical score is 85.

APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were selected for tryout in the norms on the basis of a qualitative analysis of job duties involved and a statistical analysis of test and criterion data. Aptitude M which does not have a significant correlation with the criterion was considered for inclusion in the norms because the job analysis indicated that this aptitude was important for job duties and the sample had a relatively high mean. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on the job analysis, the aptitudes indicated appear to be important to the work performed)

Aptitude	Rationale
G - General Learning Ability	Required to comprehend text, lecture, and laboratory information pertaining to theory and methods of instrumentation, as well as construction, operation, and courses of malfunction of pneumatic and electronic control-instruments.
N - Numerical Aptitude	Required for arithmetic, algebraic, and trigonometric computations of electrical and electronic formulas.
S - Spatial Aptitude	Required to read blueprints, schematics, and assembly diagrams and to visualize actual assemblies of equipment from such materials and to recognize spatial relationships of parts during disassembly of instruments in laboratory.
F - Finger Dexterity	Required to work rapidly and accurately with hands and fingers in laboratory exercises involving disassembly, assembly, and calibration of instruments.
M - Manual Dexterity	Required to work rapidly and accurately with hands and fingers in laboratory exercises involving disassembly, assembly, and calibration of instruments.

TABLE 4

Means, Standard Deviations (SD), Ranges, and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB; N=65

Aptitude	Mean	SD	Range	r
G-- General Learning Ability	110.3	14.9	74-152	.418**
V - Verbal Aptitude	101.9	13.6	74-141	.314*
N - Numerical Aptitude	107.4	14.4	75-149	.342**
S - Spatial Aptitude	118.4	18.0	71-156	.273*
P - Form Perception	110.2	15.9	71-156	.116
Q - Clerical Perception	107.2	14.0	79-150	.063
K - Motor Coordination	109.5	15.5	80-136	.065
F - Finger Dexterity	106.5	17.4	72-148	.069
M - Manual Dexterity	120.4	20.5	58-152	-.058

*Significant at the .05 level
**Significant at the .01 level

TABLE 5

Summary of Qualitative and Quantitative Data

Type of Evidence	Aptitudes								
	G	V	N	S	P	Q	K	F	M
Job Analysis Data									
Important	X		X	X				X	X
Irrelevant									
Relatively High Mean	X			X	X				X
Relatively Low Standard Dev.	X	X	X			X			
Significant Correlation with Criterion	X	X	X	X					
Aptitudes to be Considered for Trial Norms	G	V	N	S	P*				M

* Considered in validation sample because it had the highest correlation with the criterion in check Study #1

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of aptitudes G, V, N, S, and M at trial cutting scores were able to differentiate between the 72% of the sample considered good trainees and the 28% of the sample considered poor trainees. Trial cutting scores at five-point intervals approximately one standard deviation below the mean are tried because this will eliminate about one third of the sample with three aptitude norms. For two-aptitude trial norms, minimum cutting scores slightly higher than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores slightly lower than one standard deviation below the mean will eliminate about one-third of the sample. The Phi Coefficient was used as a basis for comparing trial norms. Norms of N-85, S-100 and P-80 provided the highest degree of differentiation for the occupation of Instrument Repairman I 710.281. The validity of these norms is shown

in Table 6 and is indicated by a Phi Coefficient of .35 (statistically significant at the .005 level).

TABLE 6

Predictive Validity of Test Norms N-85, S-100 and P-80

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Workers	3	44	47
Poor Workers	6	12	18
Total	9	56	65

Phi Coefficient ϕ = .35 Chi Square (X^2) = 7.9
Significance Level = P/2 $<$ .005

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study did not meet the requirements for incorporating the occupation studied into any of the 36 OAP's included in Section II of the Manual for the General Aptitude Test Battery. The data for this sample will be considered for future groupings of occupations in the development of new occupational aptitude patterns.

GATB Study #2634 S-318R

Instrument Repairman I (any ind.) 710.281
Check Study #1 Research Summary

Sample: 58 male trainees in a Manpower and Development Training (MDTA) course conducted at the Texas Trail Area Technical School Monroeville, Pennsylvania in 1962-1965.

TABLE 7

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Aptitudes of the GATB; N=58 - Cross Validation Sample #1

	Mean	SD	Range	r
Age (years)	31.6	9.3	17-50	-.184
Education (years)	11.9	0.9	9-15	.002
G - General Learning Ability	105.8	13.4	77-147	.257
V - Verbal Aptitude	103.1	13.1	76-135	.140
N - Numerical Aptitude	103.2	13.3	69-135	.293*
S - Spatial Aptitude	107.2	19.6	65-156	.242
P - Form Perception	98.6	16.4	64-145	.387**
Q - Clerical Perception	102.0	14.2	75-145	.212
K - Motor Coordination	94.3	17.5	62-132	.243
F - Finger Dexterity	91.4	20.5	53-139	.025
M - Manual Dexterity	96.6	22.6	26-137	.133

*Significant at the .05 level **Significant at the .01 level

Criterion:
Instructor ratings

Design:
Longitudinal (tests were administered at the beginning of training and criterion data were collected at the end of training).

Principal Activities:
The MDTA course provides training for the job duties shown in the job description in the Appendix.

Predictive Validity:
Phi Coefficient = .26 (P/2 less than .025)

Effectiveness of Norms:

Only 64% of the non-test-selected trainees used for this study were good trainees; if the trainees had been test-selected with the above norms, 75% would have been good trainees. 36% of the non-test-selected trainees used for this study were poor trainees; if the trainees had been test-selected with the above norms, only 25% would have been poor trainees. The effectiveness of the norms when applied to this independent sample is shown graphically in Table 8.

TABLE 8

Effectiveness of Norms on Check Study #1

	Without Test	With Test
Good Trainees	64%	75%
Poor Trainees	36%	25%

Predictive Validity of Test Norms
(N-85, S-100, P-80)
Check Study Sample #1 (Pennsylvania)

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Trainees	13	24	37
Poor Trainees	13	8	21
Total	26	32	58

Phi Coefficient (ϕ) = .26
Chi Square (X^2) = 3.8
Significance Level = P/2 < .025

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FACT SHEET

Job Title: Instrument Repairman (any ind.) I 710.281

Job Summary: Installs, repairs, adjusts, and calibrates pneumatic, electrical, and electronic control instruments, analyzers, and computers used in petrochemical plants and petroleum refineries to record, regulate, and control process conditions. Tests instruments for malfunction, using such test equipment as pyrometers, resistance boxes, potentiometers, millivolt meters, circuit testers, flow and pressure gauges. Replaces defective instruments and installs new instruments, using hand tools for cutting, bending and flaring copper tubing, uses such mechanics hand tools as wrenches, screwdrivers, and pliers. Operates hoist to raise, lower, and position large instruments. Dismantles instruments using hand tools. Cleans parts with cleaning fluid and compressed air. Examines parts for damage, verifying dimensions and clearances with thickness gauges and micrometers. Replaces worn or broken parts. Tests performance of pneumatic instruments, using weight, gauge, and vacuum-machine testers and water manometers (pressure gauges). Tests performance of electrical and electronic instruments with millivolt calibrator, cathode ray oscilloscope, capacitor analyzer, volt-ohm-milliammeter, potentiometers, tube and condenser checkers, signal generator, wheatstone bridge and galvanometers, performing duties as described under Electronic Mechanic. Connects instruments to test panels and compares readings to standardized instruments to verify calibrations. Adjusts calibration screws with screwdriver to synchronize readings with standarized instruments. Maintains stock and requisitions replacement parts and materials. Similarly maintains and repairs test equipment. Confers with operating personnel to resolve operating problems relating to instrumentation.

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GPO 919-848

January 1967 S-318R

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